

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER

Mo-6591/LeA 33.454

U.S. APPLICATION NO. (if known, see 37 CFR 1.5

To be Assigned 00/937467

INTERNATIONAL APPLICATION NO.

PCT/EP00/02240

INTERNATIONAL FILING DATE

14 March 2000 (14.03.00)

PRIORITY DATE CLAIMED

27 March 1999 (27.03.99)

TITLE OF INVENTION DEVICE AND METHOD FOR DEGASSING PLASTICS

APPLICANT(S) FOR DO/EO/US 1) Thomas Elsner; 2) Jurgen Heuser; 3) Christian Kords

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☒ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:

PTO Form 1449 and references listed therein; Preliminary Amendment w/Abstract; 1 drawing containing Fig. 1

U.S. APPLICATION NO. 01/123,456
To be Assigned **937467**INTERNATIONAL APPLICATION NO.
PCT/EP00/02240ATTORNEY'S DOCKET NUMBER
Mo-6591/LeA 33,45421. ☒ The following fees are submitted:**BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):**

Neither international preliminary examination fee (37 CFR 1.482)
nor international search fee (37 CFR 1.445(a) (2)) paid to USPTO
and International Search Report not prepared by the EPO or JPO \$1000.00

International preliminary examination fee (37 CFR 1.482) not paid to
USPTO but International Search Report prepared by the EPO or JPO \$860.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO
but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO
but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO
and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =**CALCULATIONS PTO USE ONLY**

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30
months from the earliest claimed priority date (37 CFR 1.492(e)).

\$ 860.00

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$
Total claims	24 -20 =	4	x \$18.00	\$ 72.00
Independent claims	2 -3 =	0	x \$80.00	\$ 0.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+ \$270.00
TOTAL OF ABOVE CALCULATIONS =				\$ 932.00
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				+ \$ 0.00
SUBTOTAL =				\$ 932.00
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$
TOTAL NATIONAL FEE =				\$ 932.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$ 40.00
TOTAL FEES ENCLOSED =				\$ 972.00
				Amount to be refunded: \$
				charged: \$

09/937467

JC03 Rec'd PCT/PTO 25 SEP 2001

PATENT APPLICATION
Mo-6591
LeA 33,454

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION OF)
THOMAS ELSNER ET AL) PCT/EP00/02240
SERIAL NUMBER: TO BE ASSIGNED)
FILED: HERewith)
TITLE: DEVICE AND METHOD FOR)
DEGASSING PLASTICS)

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

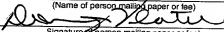
This preliminary amendment is being filed concurrently with the subject patent application. Upon granting a Serial Number and filing date, please amend the subject patent application as follows.

"Express Mail" mailing label number EF146899217US
Date of Deposit September 25, 2001

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner of Patents and Trademarks, Washington, D.C. 20231

Donna J. Veatch

(Name of person mailing paper or fee)


(Signature of person mailing paper or fee)

Please amend the Application as follows.

IN THE ABSTRACT:

Please replace the abstract with the following.

--DEVICE AND METHOD FOR DEGASSING PLASTICS

ABSTRACT OF THE DISCLOSURE

An apparatus for degassing plastic materials, e.g., high molecular weight polycarbonate solutions, is described. The apparatus includes a double-shaft extruder having a length-to-diameter ratio of less than or equal to 40, which comprises: (i) two co-rotating and meshing shafts; (ii) an intake opening; and (iii) upstream and downstream portions relative to the intake opening. The shafts of the extruder are designed with a double lead in a degassing zone, and with a triple lead in a pressure build-up zone. Each of the degassing and the pressure build-up zones are down-stream from the intake opening, and the pressure build-up zone is further down-stream than the degassing zone. Also described is a process for degassing plastic materials, which involves providing the described double-shaft co-rotating extruder, into which plastic material is fed, processed and degassed. Entraining agents, such as nitrogen, and other processing additives may be introduced into extruder during the process of the present invention.--

An abstract is included herewith on a separate page.

IN THE SPECIFICATION:

Please replace the title at lines 2 and 3 of page 1 of the specification with the following.

--DEVICE AND METHOD FOR DEGASSING PLASTICS --

Please insert the following between lines 2 and 5 on page 1 of the specification.

--CROSS REFERENCE TO RELATED PATENT APPLICATIONS

The present patent application claims the right of priority under 35 U.S.C. 119 Mo-6591

(a)-(d) and 35 U.S.C. 365 of International Application No. PCT/EP00/02240, filed 14 March 2000, which was published in German as International Patent Publication No. WO 00/58072 on 5 October 2000, which is entitled to the right of priority of German Patent Application No. 199 14 143.6, filed 27 March 1999.

FIELD OF THE INVENTION--

Please insert the following at line 9 on page 1 of the specification.

--BACKGROUND OF THE INVENTION--

Please insert the following at line 35 on page 1 of the specification.

--SUMMARY OF THE INVENTION--

Please insert the following between lines 7 and 9 on page 2 of the specification.

--BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is a schematic representation of a longitudinal section of a double-shaft extruder of an apparatus according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION--

Please replace line 1 of page 5 of the specification with the following.

--WHAT IS CLAIMED IS:--

IN THE CLAIMS:

Please cancel Claims 1-22 without prejudice.

Please add the following Claims 23-46.

--23. An apparatus for degassing plastic materials comprising a double-shaft extruder, said double shaft extruder comprising:

- (i) two shafts rotating in the same direction and meshing with one another;

(ii) an intake opening; and

(iii) upstream and downstream portions relative to said intake opening, wherein the extruder has a length-to-diameter ratio of less than or equal to 40, the shafts of the extruder are designed with a double lead in a degassing zone of the extruder, and with a triple lead in a pressure build-up zone of the extruder, each of said degassing zone and said pressure build-up zone being down-stream from said intake opening, and said pressure build-up zone being further down-stream than said degassing zone.

24. The apparatus of Claim 23 wherein the length-to-diameter ratio is from 35 to 40.

25. The apparatus of Claim 23 wherein said extruder further comprises a cooling device defining a cooling zone.

26. The apparatus of Claim 25 wherein the shafts are designed with a triple lead in the cooling zone.

27. The apparatus of Claim 23 wherein kneading elements are disposed immediately downstream from said intake opening, said kneading elements being located between feed elements of said shafts.

28. The apparatus of Claim 23 wherein said extruder comprises a plurality of degassing zones located downstream from said intake opening, each of said degassing zones having an exhausting device connected thereto.

29. The apparatus of Claim 28 wherein the shafts have a triple-lead profile in a region between two of said degassing zones.

30. The apparatus of Claim 28 wherein said extruder further comprises an agent inlet located in a region between two of said degassing zones.

31. The apparatus of Claim 28 wherein said extruder comprises first, second and third degassing zones, and an entraining agent inlet located between the second and third degassing zones.

32. The apparatus of Claim 23 wherein a backward degassing vent opening is located upstream from said intake opening.

33. The apparatus of Claim 28 wherein said plurality of degassing zones comprises a last degassing zone located furthest downstream from said intake opening, said extruder further comprising an additive admixing charging device located in said last degassing zone.

34. A process for degassing a plastic material comprising:

- (a) providing a double-shaft extruder comprising,
 - (i) two shafts rotating in the same direction and meshing with one another,
 - (ii) an intake opening, and
 - (iii) upstream and downstream portions relative to said intake opening,

wherein the extruder has a length-to-diameter ratio of less than or equal to 40, the shafts of the extruder are designed with a double lead in a degassing zone of the extruder, and with a triple lead in a pressure build-up zone of the extruder, each of said degassing zone and said pressure build-up zone being down-stream from said intake opening, and said pressure build-up zone being further down-stream than said degassing zone; and

- (b) feeding said plastic material into said intake opening.

35. The process of Claim 34 wherein the length-to-diameter ratio of the extruder is from 35 to 40.

36. The process of Claim 34 wherein said extruder further comprises a cooling device defining a cooling zone.

37. The process of Claim 36 wherein the shafts are designed with a triple lead in the cooling zone.

38. The process of Claim 34 wherein said extruder comprises a plurality of degassing zones located downstream from said intake opening, each of said degassing zones having an exhausting device connected thereto, said degassing zones defining a plurality of forward degassing zones.

39. The process of Claim 38 wherein said extruder further comprises a backward degassing vent opening located upstream from said intake opening.

40. The process of Claim 38 wherein said extruder comprises first, second and third degassing zones, the absolute pressure generated by the exhausting device of said first degassing zone being from 0.5 to 1.5 bar, the absolute pressure generated by the exhausting device of said second degassing zone being from 0.03 to 1.9 bar, and the degassing pressure generated by the exhausting device of said third degassing zone being from 0.001 to 0.03 bar.

41. The process of Claim 34 further comprising admixing an entraining agent into the plastic material within said extruder.

42. The process of Claim 38 wherein said extruder comprises first, second and third degassing zones and an entraining agent is introduced into the plastic material within said extruder between said second and third degassing zones.

43. The process of Claim 42 wherein said entraining agent is nitrogen.

44. The process of Claim 43 wherein the shafts of said extruder are rotated at a speed of less than 390 revolutions per minute, and said entraining agent is introduced into said extruder at a volume rate of 2 to 10 Nm³/h.

45. The process of Claim 38 wherein said plurality of degassing zones comprises a last degassing zone located furthest downstream from said intake opening, and said pressure build-up zone is adjoined to said last degassing zone.

46. The process of Claim 34 wherein said plastic material is a high-molecular polycarbonate solution.--

REMARKS

Claims in the case are 23-46 upon entry of this amendment. Claims 1-22 have been cancelled and Claims 23-46 have been added by amendment herein. Basis for added Claims 23-46 is found in original Claims 1-22.

The specification has been amended to include section headings, in accordance with accepted practice before the Office. The title of the application has been changed to correspond with a shortened version of the title of the related International Patent Publication No. WO 00/58072. Basis for the Brief Description of the Drawing inserted on page 2 of the specification by amendment herein, is found at page 3, lines 14-16 of the specification. Page 1 of the application has been amended herein to introduce cross reference information. The cross reference information is presented in accordance with 37 C.F.R. 1.78(a)(2) (Federal Register / Vol. 65, No. 183 / Wednesday, September 20, 2000; Changes to Implement Eighteen-Month Publication of Patent Applications; Final Rule). An abstract of the disclosure is also included herewith on a separate page.

The amendments and added claims presented herein are not believed to represent the entry of new matter into the application. Applicants respectfully request entry of this preliminary amendment.

Respectfully submitted,

By James R. Franks
James R. Franks
Agent for Applicants
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VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

IN THE ABSTRACT:

The abstract has been replaced with the following.

--DEVICE AND METHOD FOR DEGASSING PLASTICS

ABSTRACT OF THE DISCLOSURE

An apparatus for degassing plastic materials, e.g., high molecular weight polycarbonate solutions, is described. The apparatus includes a double-shaft extruder having a length-to-diameter ratio of less than or equal to 40, which comprises: (i) two co-rotating and meshing shafts; (ii) an intake opening; and (iii) upstream and downstream portions relative to the intake opening. The shafts of the extruder are designed with a double lead in a degassing zone, and with a triple lead in a pressure build-up zone. Each of the degassing and the pressure build-up zones are down-stream from the intake opening, and the pressure build-up zone is further down-stream than the degassing zone. Also described is a process for degassing plastic materials, which involves providing the described double-shaft co-rotating extruder, into which plastic material is fed, processed and degassed. Entraining agents, such as nitrogen, and other processing additives may be introduced into extruder during the process of the present invention.--

An abstract is included herewith on a separate page.

IN THE SPECIFICATION: (Marked-Up)

The following are changes and additions made to the specification.

The title at lines 2 and 3 on page 1 of the application has been amended as follows.

[Apparatus and process for degassing plastic materials, in particular high-molecular polycarbonate solutions] DEVICE AND METHOD FOR DEGASSING PLASTICS

The following has been inserted between lines 2 and 5 on page 1 of the specification.

—CROSS REFERENCE TO RELATED PATENT APPLICATIONS

The present patent application claims the right of priority under 35 U.S.C. 119 (a)-(d) and 35 U.S.C. 365 of International Application No. PCT/EP00/02240, filed 14 March 2000, which was published in German as International Patent Publication No. WO 00/58072 on 5 October 2000, which is entitled to the right of priority of German Patent Application No. 199 14 143.6, filed 27 March 1999.

FIELD OF THE INVENTION--

The following has been inserted at line 9 on page 1 of the specification.

--BACKGROUND OF THE INVENTION--

The following has been inserted at line 35 on page 1 of the specification.

--SUMMARY OF THE INVENTION--

The following has been inserted between lines 7 and 9 on page 2 of the specification.

--BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is a schematic representation of a longitudinal section of a double-shaft extruder of an apparatus according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION--

Line 1 of page 5 of the specification has been amended as follows.

[Claims] WHAT IS CLAIMED IS:

IN THE CLAIMS:

Claims 1-22 have been cancelled without prejudice.

The following Claims 23-46 have been added.

--23. An apparatus for degassing plastic materials comprising a double-shaft extruder, said double shaft extruder comprising:

- (i) two shafts rotating in the same direction and meshing with one another;
- (ii) an intake opening; and
- (iii) upstream and downstream portions relative to said intake opening,

wherein the extruder has a length-to-diameter ratio of less than or equal to 40, the shafts of the extruder are designed with a double lead in a degassing zone of the extruder, and with a triple lead in a pressure build-up zone of the extruder, each of said degassing zone and said pressure build-up zone being down-stream from said intake opening, and said pressure build-up zone being further down-stream than said degassing zone.

24. The apparatus of Claim 23 wherein the length-to-diameter ratio is from 35 to 40.

25. The apparatus of Claim 23 wherein said extruder further comprises a cooling device defining a cooling zone.

26. The apparatus of Claim 25 wherein the shafts are designed with a triple lead in the cooling zone.

27. The apparatus of Claim 23 wherein kneading elements are disposed immediately downstream from said intake opening, said kneading elements being located between feed elements of said shafts.

28. The apparatus of Claim 23 wherein said extruder comprises a plurality of degassing zones located downstream from said intake opening, each of said degassing zones having an exhausting device connected thereto.

29. The apparatus of Claim 28 wherein the shafts have a triple-lead profile in a region between two of said degassing zones.

30. The apparatus of Claim 28 wherein said extruder further comprises an agent inlet located in a region between two of said degassing zones.

31. The apparatus of Claim 28 wherein said extruder comprises first, second and third degassing zones, and an entraining agent inlet located between the second and third degassing zones.

32. The apparatus of Claim 23 wherein a backward degassing vent opening is located upstream from said intake opening.

33. The apparatus of Claim 28 wherein said plurality of degassing zones comprises a last degassing zone located furthest downstream from said intake opening, said extruder further comprising an additive admixing charging device located in said last degassing zone.

34. A process for degassing a plastic material comprising:

- (a) providing a double-shaft extruder comprising,
 - (i) two shafts rotating in the same direction and meshing with one another,
 - (ii) an intake opening, and
 - (iii) upstream and downstream portions relative to said intake opening,

wherein the extruder has a length-to-diameter ratio of less than or equal to 40, the shafts of the extruder are designed with a double lead in a degassing zone of the extruder, and with a triple lead in a pressure

build-up zone of the extruder, each of said degassing zone and said pressure build-up zone being down-stream from said intake opening, and said pressure build-up zone being further down-stream than said degassing zone; and

- (b) feeding said plastic material into said intake opening.

35. The process of Claim 34 wherein the length-to-diameter ratio of the extruder is from 35 to 40.

36. The process of Claim 34 wherein said extruder further comprises a cooling device defining a cooling zone.

37. The process of Claim 36 wherein the shafts are designed with a triple lead in the cooling zone.

38. The process of Claim 34 wherein said extruder comprises a plurality of degassing zones located downstream from said intake opening, each of said degassing zones having an exhausting device connected thereto, said degassing zones defining a plurality of forward degassing zones.

39. The process of Claim 38 wherein said extruder further comprises a backward degassing vent opening located upstream from said intake opening.

40. The process of Claim 38 wherein said extruder comprises first, second and third degassing zones, the absolute pressure generated by the exhausting device of said first degassing zone being from 0.5 to 1.5 bar, the absolute pressure generated by the exhausting device of said second degassing zone being from 0.03 to 1.9 bar, and the degassing pressure generated by the exhausting device of said third degassing zone being from 0.001 to 0.03 bar.

41. The process of Claim 34 further comprising admixing an entraining agent into the plastic material within said extruder.

42. The process of Claim 38 wherein said extruder comprises first, second and third degassing zones and an entraining agent is introduced into the plastic material within said extruder between said second and third degassing zones.

43. The process of Claim 42 wherein said entraining agent is nitrogen.

44. The process of Claim 43 wherein the shafts of said extruder are rotated at a speed of less than 390 revolutions per minute, and said entraining agent is introduced into said extruder at a volume rate of 2 to 10 Nm³/h.

45. The process of Claim 38 wherein said plurality of degassing zones comprises a last degassing zone located furthest downstream from said intake opening, and said pressure build-up zone is adjoined to said last degassing zone.

46. The process of Claim 34 wherein said plastic material is a high-molecular polycarbonate solution.--

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- 8 -

DEVICE AND METHOD FOR DEGASSING PLASTICSABSTRACT OF THE DISCLOSURE

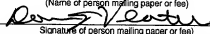
An apparatus for degassing plastic materials, e.g., high molecular weight polycarbonate solutions, is described. The apparatus includes a double-shaft extruder having a length-to-diameter ratio of less than or equal to 40, which comprises: (i) two co-rotating and meshing shafts; (ii) an intake opening; and (iii) upstream and downstream portions relative to the intake opening. The shafts of the extruder are designed with a double lead in a degassing zone, and with a triple lead in a pressure build-up zone. Each of the degassing and the pressure build-up zones are down-stream from the intake opening, and the pressure build-up zone is further down-stream than the degassing zone. Also described is a process for degassing plastic materials, which involves providing the described double-shaft co-rotating extruder, into which plastic material is fed, processed and degassed. Entraining agents, such as nitrogen, and other processing additives may be introduced into extruder during the process of the present invention.

Le A 33 454

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner of Patents and Trademarks, Washington, D.C. 20231

Donna J. Veatch

(Name of person mailing paper or fee)



Signature of person mailing paper or fee

Apparatus and process for degassing plastic materials, in particular high-molecular polycarbonate solutions

09/937467

JC03 Rec'd POSTNET 25 SEP 2001

- 5 The invention relates to an apparatus and a process for degassing plastic materials, in particular high-molecular polycarbonate solutions, by means of a double-shaft extruder, which comprises shafts rotating in the same direction and meshing with one another.
- 10 As a result of heightened environmental awareness, increasing demands regarding the removal of volatile components from plastic materials are being placed on the plastics processing industry. This applies particularly with regard to the use of plastic materials in the food sector. The volatile components in the extruded plastic material mostly may not exceed 0.2% by weight and are required to be removed in order to
- 15 improve the product quality, especially the optical properties. This applies particularly to products made from high-molecular polycarbonate solutions containing chlorobenzene and methylene dichloride as volatile components. In the plastics industry, the removal of volatile components from polymers is known as degassing. Various apparatuses are used for degassing, in particular single- and twin-screw
- 20 extruders.
- In the case of degassing by means of single- and twin-screw extruders, a distinction is made between forward and backward degassing as well as single and multiple degassing. With forward degassing the vent opening of the extruder is disposed - in
- 25 feed direction of the screw - downstream of the intake of the extruder, whereas with backward degassing it is disposed - in feed direction of the screw - upstream of the intake. Degassing extruders are also used, in which both forward and backward degassing are effected. Depending on the desired residual content of volatile components, single-stage or multi-stage degassing is effected. The number of
- 30 degassing stages cannot however be increased indefinitely because this entails an increase in the manufacturing cost of the product and frequently also a decrease in product quality. The product quality in said case is particularly dependent upon the processing temperature or the temperature rise as well as the retention time in the extruder of the plastic material to be degassed.

35

The object of the invention is to provide an apparatus and a process of the type described initially, which lead to an economical improvement of product quality, and

indeed in particular enable manufacture of polycarbonate of a particularly high transmittancy.

5 Said object is achieved according to the invention in that the shafts of the extruder are designed with a double lead in the degassing zone and with a triple lead in the pressure build-up zone of the extruder and the extruder has an L:D ratio smaller than/equal to 40, wherein L is the respective screw length and D the respective screw diameter.

10 Conventional degassing extruders achieve, e.g. in the case of high-molecular types of polycarbonate, transmittancy values of 87 to 88. In comparison, with the apparatus according to the invention and the corresponding process it is surprisingly possible to achieve transmittancy values of 88.5 to 89.5 for said types of polycarbonate.

15 Furthermore, the cost of manufacturing the product may be reduced because the extruder of the apparatus according to the invention is of a relatively short design and so the spatial requirement and the cost of the apparatus are correspondingly reduced.

20 Particularly high transmittancy values were achieved with a twin-screw extruder having an L:D ratio in the region of 35 to 40.

25 To avoid temperature-related quality losses, it is advantageous when the extruder moreover comprises a cooling device defining a cooling zone. In said manner, the product quality may be positively influenced. The shafts of the extruder are preferably designed with a triple lead in the cooling zone.

30 According to another preferred refinement, kneading elements are disposed immediately downstream of the intake opening of the extruder between the feed elements of the shafts. The kneading elements are used to introduce energy and in particular to increase the degassing surface.

35 A high degree of degassing may be achieved particularly when, according to a further refinement, the extruder in feed direction comprises a plurality of degassing zones, to each of which an exhausting device is connected. Very good results were achieved with an extruder which comprises, in feed direction, downstream of the intake opening three degassing zones, wherein there was generated at the vent opening associated with the first degassing zone an absolute pressure in the region of 0.5 to 1.5 bar, at the vent opening associated with the second degassing zone an absolute pressure in the region

of 0.03 to 1.9 bar, and at the vent opening associated with the third degassing zone an absolute pressure in the region of 0.001 to 0.03 bar.

5 The degassing may moreover be positively influenced by an entraining agent which increases the degassing surface. In the process according to the invention, the entraining agent is admixed preferably in feed direction between a second and third degassing zone. Nitrogen may preferably be used as an entraining agent. The volume rate of flow of the supplied nitrogen should be preferably 2 to 10 Nm³/h, given a shaft rotational speed lower than/equal to 390 rpm.

10

Further preferred and advantageous refinements of the invention are indicated in the sub-claims.

15

There now follows a detailed description of the invention with reference to a drawing illustrating an embodiment. The single figure shows a diagrammatic longitudinal section of a double-shaft extruder of an apparatus according to the invention.

20

The double-shaft extruder comprises a housing, which is composed of eight parts altogether and in which are disposed two shafts (not shown), which rotate in the same direction and mesh with one another. The plastic material to be degassed is supplied to the extruder through the intake opening 2 formed in the first housing part 1. Disposed in feed direction upstream of the intake opening 2 is a vent opening 3 (backward degassing). The drive ends of the shafts are led outwards through a floating ring seal (not shown) at the, in the figure, left side of the first housing part 2.

25

Adjoining the first housing part 1 in feed direction is a second housing part 4 of approximately the same length, which has a further vent opening 5. This is followed by a third, longer housing part 6, which is adjoined by a fourth, relatively short housing part 7 followed by a fifth housing part 8, the length of which corresponds to the length of the third housing part 6. The third and fifth housing part 6, 8 have vent openings 9, 10 of equal size, which are more than twice as long as the vent opening 5 of the second housing part 4. The vent openings 5, 9 and 10 are connected to an exhausting device (not shown).

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The fourth housing part 7 is provided with a connection 11, via which an entraining agent, preferably nitrogen, may be admixed.

The fifth housing part 8 is followed by three housing parts 12, 13, 14 of approximately equal size, which form a pressure build-up zone, at the end of which the degassed product leaves the extruder. It is evident that a connection opening 15 is formed in the sixth housing part 12. Said connection opening may be used to connect a lateral
5 extruder, by means of which additives may be added to the degassed product.

In the region of said pressure build-up zone, the shafts have a triple-lead profile.

10 Kneading elements are disposed immediately downstream of the intake opening 2 between the feed elements of the shafts. In the region of the housing parts 1, 4, 6, 7 and 8 the shafts are designed with a double lead. The double-lead and triple-lead shaft profiles in said case have differing angles of lead and/or directions of lead.

15 The apparatus according to the invention is operated in such a way that there is at the first vent opening 3 an absolute pressure of 1 to 2 bar, at the second vent opening 5 an absolute pressure of 2.5 to 1.5 bar, at the third vent opening 9 an absolute pressure of 0.03 to 0.9 bar and at the fourth vent opening 10 an absolute pressure of 0.001 to 0.03 bar.

20 The double-shaft extruder preferably operates at a rotational speed which is lower than/equal to 390 rpm. The volume rate of flow of the supplied nitrogen is preferably 2 to 10 Nm³/h.

25 To avoid temperature-related quality losses, the extruder is provided with a cooling device (not shown). The cooling device is formed preferably in the region of the housing parts 12, 13, 14.

30 It has been shown that with an apparatus configured in said manner it is possible to manufacture a polycarbonate of a particularly high transmittancy, namely transmittancy values of 88.5 to 89.5 in the case of high-molecular (valency number 1.33) types of polycarbonate.

Claims

1. Apparatus for degassing plastic materials, in particular high-molecular polycarbonate solutions, having a double-shaft extruder, which comprises shafts rotating in the same direction and meshing with one another, characterized in that the extruder has a length-to-diameter ratio less than/equal to 40, wherein the shafts are designed with a double lead in the degassing zone of the extruder and with a triple lead in the pressure build-up zone of the extruder.
2. Apparatus according to claim 1, characterized in that the length-to-diameter ratio is in the region of 35 to 40.
3. Apparatus according to claim 1 or 2, characterized in that the extruder further comprises a cooling device defining a cooling zone.
4. Apparatus according to claim 3, characterized in that the shafts are designed with a triple lead in the cooling zone.
5. Apparatus according to one of the preceding claims, characterized in that kneading elements are disposed immediately downstream of the intake opening (2) of the extruder between the feed elements of the shafts.
6. Apparatus according to one of the preceding claims, characterized in that the extruder in feed direction comprises a plurality of degassing zones, to each of which an exhausting device is connected.
7. Apparatus according to one of the preceding claims, characterized in that the shafts have a triple-lead profile in the region between two degassing zones.
8. Apparatus according to one of the preceding claims, characterized in that the extruder comprises an entraining agent inlet (11) disposed between two degassing zones.
9. Apparatus according to claim 8, characterized in that the extruder in feed direction comprises three degassing zones, wherein the entraining agent inlet (11) is disposed between the second and the third degassing zone.

10. Apparatus according to one of the preceding claims, characterized in that disposed upstream of the intake opening (2) of the extruder is a vent opening (3) used for backward degassing.
- 5 11. Apparatus according to one of the preceding claims, characterized in that disposed downstream of the - in feed direction - last degassing zone is a charging device (15) for admixing additives.
- 10 12. Process for degassing plastic materials, in particular high-molecular polycarbonate solutions, by means of a double-shaft extruder, which comprises shafts rotating in the same direction and meshing with one another, characterized in that the shafts are designed with a double lead in the degassing zone of the extruder and with a triple lead in the pressure build-up zone of the extruder and the extruder has a length-to-diameter ratio smaller than/equal to 40.
- 15 13. Process according to claim 12, characterized in that the length-to-diameter ratio is in the region of 35 to 40.
- 20 14. Process according to claim 12 or 13, characterized in that the plastic material is cooled.
- 25 15. Process according to claim 14, characterized in that the shafts are designed with a triple lead in the region of the cooling zone.
- 30 16. Process according to one of claims 12 to 15, characterized in that the degassing of the plastic material is effected in the form of forward degassing or a combination of forward and backward degassing, wherein the forward degassing is effected in a plurality of stages and volatile components of the plastic material are removed in each degassing stage by means of an exhausting device.
- 35 17. Process according to one of claims 12 to 16, characterized in that the extruder in feed direction comprises three degassing zones, wherein there is generated at the vent opening (5) associated with the first degassing zone an absolute pressure in the region of 0.5 to 1.5 bar, at the vent opening (9) associated with

the second degassing zone an absolute pressure in the region of 0.03 to 1.9 bar and at the vent opening (10) associated with the third degassing zone an absolute pressure in the region of 0.001 to 0.03 bar.

- 5 18. Process according to one of claims 12 to 17, characterized in that an entraining agent is admixed with the plastic material.
- 10 19. Process according to claims 18 and 19, characterized in that the entraining agent is admixed in feed direction between the second and the third degassing zone.
- 15 20. Process according to claim 18 or 19, characterized in that nitrogen is used as an entraining agent.
- 20 21. Process according to claim 20, characterized in that the extruder is operated at a rotational speed lower than/equal to 390 rpm and the volume rate of flow of the supplied nitrogen is 2 to 10 Nm³/h.
- 20 22. Process according to one of claims 12 to 21, characterized in that the - in feed direction - last degassing zone is adjoined by a pressure build-up zone.

Apparatus and process for degassing plastic materials, in particular high-molecular polycarbonate solutions

Abstract

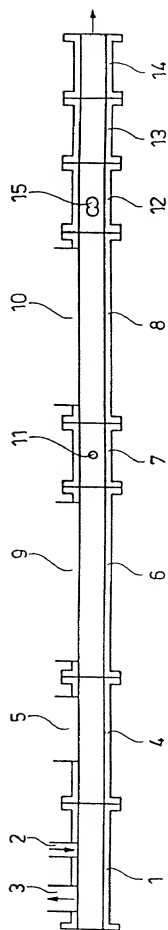
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An apparatus for degassing plastic materials, in particular high-molecular polycarbonate solutions, is described, having a double-shaft extruder, which comprises shafts rotating in the same direction and meshing with one another. The apparatus is characterized in that the extruder has a length-to-diameter ratio smaller than/equal to 40, wherein the shafts are designed with a double lead in the degassing zone of the extruder and with a triple lead in the pressure build-up zone of the extruder. The apparatus enables economical manufacture of a polycarbonate of a particularly high transmittancy. A corresponding process is moreover described.

10

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The single figure of the drawing is provided for publication.



As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name. I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

**DEVICE AND METHOD FOR DEGASSING PLASTICS, ESPECIALLY
POLYCARBONATE SOLUTIONS OF HIGH MOLECULAR WEIGHT**

the specification of which is attached hereto,

or was filed on **March 14, 2000**

as a PCT Application Serial No. **PCT/EP00/02240**

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s), the priority(ies) of which is/are to be claimed:

199 14 143.6
(Number)

Germany
(Country)

March 27, 1999
(Month/Day/Year Filed)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose the material information as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)

(Filing Date)

(Status)

(patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status)

(patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Le A 33 454-US

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